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An Inaugural Eſsay
On the
Proceſs employed by nature
In Suppreſsing Hemorrhage,
for the
Degree of Doctor of Medicine
in the
University of Pennsylvania
By
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Of
South Carolina.

The accidents to which mankind is liable are so diversified and complicated that to a reflecting mind it must be a matter of surprise that there are not a vastly greater number of victims to them than we actually observe: this surprise is increased by the conviction that they are often rendered doubly dangerous by the blunders of the ignorant and officious: even those from whome more should be expected are frequently found deficient, and their ill timed interference with nature where she is amply sufficient to repair ~~to repair~~ the injury sustained, not unfrequently commits the unfortunate, to unnecessary torture, but oftentimes to an untimely grave. On the other hand when assistance is plainly demanded, either ignorance of the proper means to be

adopted, or a want of self-command, which should at all times be the hand maid of every surgeon, render him a mere machine, vacillating at the suggestions of every one around him, utterly regardless of what his reason in cooler moments would have dictated; and only called to a sense of his own deficiency when he sees the hand of death upon his patient. Independent of these circumstances hemorrhage when profuse may terminate life, when in the common course of things we can have no controll over it; this arises from the absolute impossibility of obtaining assistance in time, and if obtained the bleeding may proceed from vessels situated in some of the dark cavities of the body, or in places, which none but a madman would think of exploring.

It is the dread of hemorrhage

which continually stands in the way of the young surgeon, mars all his operations, and not unfrequently prevents him from taking measures for the benefit and even security of his patient, which his judgement suggests; "were this one danger removed, he would go forward in his profession almost without fear". "Un sentiment naturel attache à l'idée de perdre son sang: un terreur machinale, dont l'enfant qui commence à parler, et l'homme le plus décidé, sont egalement susceptibles. On ne peut point dire que cette peur soit chimérique. Si l'on comptoit ceux qui perdent la vie dans une bataille on verroit, que les trois quarts ont péri par quelque hemorrhagie: et dans les grandes operations de chirurgie cet est presque toujour le plus formidable"

It is surprising that a subject so

interesting in every point of view, should have excited so little attention until a period which is almost within the recollection of the present generation: The ancients ignorant alike of the proceſs which nature institutes, as of the means by which she is rationally to be aſsisted, must have fallen victims to the unrelenting attacks of such diseases as in moderen times are only to be met with a timely use of the knife; when operations were resorted to, which were seldom, their horrors were augmented by the parade of burning irons, and cauteries, that modern surgery has almost banished from the list of her remedial agents.

With all the resourses of the surgeon of the present day, hemorrhage the consequence of accidental wounds is one of the most appalling cases his feelings a man wit-

-neſsing the miseries of suffering humanity, or his profeſsional skill which is to step between the unfortunate and the grave, has to contend with: altho' death by bleeding is not the most painful, yet the imagination would find it difficult to conceive one more awful; with the flow of blood the patient feels that his spirits, and strength are on the wing, and the horror of death increases as he verges towards its confines: his friends and attendants, the anxious spectators of his fate look up to you as the ark of their safety, and the conscientious man cannot but feel the responsibility of his situation; to do all that we can for those intrusted to us, is no leſs a moral obligation, than one which society imperiously demands, and that man who can charge himself

with the death of an individual through carelessness, or neglect, has a burthen resting upon him, which subsequent exertions will hardly be able to remove.

All wounds do not afford the same facility to the flow of blood, which circumstance has been one cause of variation in their treatment, and authors generally have with great propriety made a division of them, giving to each its specific character. The following arrangement appears sufficiently correct for our purposes.

Contused wounds
Lacerated wounds
Incised wounds
Punctured wounds.

Contused and lacerated wounds differ from all others in as much as they are

not liable to profuse bleeding in the beginning: this indisposition to hemorrhage arises from the violence which has been inflicted on the vessels themselves, and on the nerves by which their vital actions are maintained, for nervous influence being destroyed, the arteries are not able to propel the blood along the injured part, it then coagulates, and it is not until the eschar has been thrown off by the processes of absorption, and suppuration, that hemorrhage takes place: this is what has been termed "secondary hemorrhage" and is decidedly the most difficult kind to suppress, because it is with reluctance that a patient will submit to the torture of having a wound torn up, and when opened the retraction of the vessels is generally so great that

* "when they do not open the artery to a greater extent than one-forth of its circumference"

it is only after a great deal of search with immense agony to the patient that they can be found, and secured: whenever we meet a wound of this kind it is our duty to guard against this circumstance by making a thorough examination of the extent of the injury, and applying our agents to sound parts.

Whenever a considerable artery has been wounded by a pointed instrument, the danger to be apprehended will be in proportion to the injury that the veſsel has sustained, for I think it can be shown that such wounds* unite with as much facility as those inflicted on any other tiſsue, but more of this hereafter.

Incised wounds being attended with none of those circumstances which so eſsentially retard the flow of blood

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from other wounds, hemorrhage is generally very profuse, and is the first circumstance to which attention is excited: being made with sharp instruments the parts are merely divided without sustaining any further injury, and their natural elasticity produces a separation of the parietes of of the wound. giving at the same time every poſsible chance for the escape of blood, and the greatest facility to the operations of the surgeon, and if proper time, and precautions be taken, he will rarely meet with serious difficulties. unleſs the wound extend into vital organs, or parts naturally beyond the sphere of his operations. Content with these few preliminary remarks, I proceed to the proceſs instituted by nature for suppreſsing Hemorrhage, and this may be a proper

place for stating, that whatever correct opinions I may entertain on this subject have been derived from Mr Jones' excellent work "on hemorrhage"...

Among the discrepencies of opinion between authors with regard to the process instituted by nature for the suppression of hemorrhage, it is difficult without actual experiment and examination to form any decided opinion; each one relies upon the infallibility of his own observations, and experiments, performed perhaps to strengthen some theoretical notions, and asserts their correctness with the dogmatical zeal of sectarians, branding those of their opponents as entirely wrong, or of giving but partial views of the subject. To experiments themselves on the lower orders of animal obje

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objections might be raised; the deductions arising from them are only to be conceded as facts, when their practical application has demonstrated their utility; this is the ordeal which is to destroy the visionary dreams of theory, and give to truth its proper ascendency.

The attention of the profeſsion was first called to this interesting subject by the celebrated Petit in 1731, and perhaps it was the impulse that it received from the magic of this great man's name that drew around it so many votaries; M. Petit's ideas are certainly correct as far as they go, but it will be shown hereafter that he took but a very partial view of the subject; he conceived that hemorrhage from a divided artery is stopped by the formation of a coagulum of blood which is situated partly

within, and partly without the veſsel. this clot afterwards adheres to the inside of the artery to its orifice, and to the surrounding parts; he adds that when hemorrhage is stopped by a ligature a coagulum is formed above the ligature, which only differs in shape from the one which takes place when no ligature is employed; these ideas led him to suppose, that the ligature did nothing more than afford support, which could be equally well effected by preſsure; hence the various contrivances that he resorted to in operation to accomplish this end — It would be difficult to say whether surgery upon the whole was benefitted or injured by Petit in this branch, for tho' perhaps last, he was not the least of those who resisted the introduction of the ligature; affording a striking illustration of the power of theoretical

opinions, so to occupy the mind as to prevent the acceſs of useful knowledge.

Morand followed Petit, and adopted his doctrines as the bases upon which he rested his own, but added an other important fact, which Mr John Bell terms "a little bit of reason for the formation of clots"; he contended that a corrugation, or plaiting of the circular fibres of the artery which diminishes its canal, and a shortning, and consequent thickning of its longitudinal, which nearly rendered it impervious, had some share in the proceſs: He also thought that the cavity of an artery might be obliterated by the puckering, or corrugation, when circular preſsure as that of a ligature is made.

Altho' Morand has aſsigned a cause

for the appearances which he observed, that anatomists generally will pronounce incorrect, as the existence of longitudinal muscular fibres has not yet been satisfactorily demonstrated, still he evidently refers to the retraction and contraction so clearly made out by Mr Jones.

M Pouteau rejects the explanations of Petit, as wholy insufficient to explain the phenomomena, and in direct opposition to the appearances observable on examination; his notions are that hemorrhage is restrained by the swelling of the cellular tiſsue surrounding the artery, "Je me crois fondé à attribuer ce reſserrement gradué de l'artère jusqu'à a l'obliteration, a la tuméfaction et au gouflement des chairs et du tiſsu cellulaire." (Oeuvres De M Pouteau) vol 2 p. 321.

The English surgeons Gooch, White,

Aiken, and Kirkland, also agree in denying the utility of the coagulum of blood of Petit. White in his "cases in Surgery" declares, that "it ~~it~~ is absolutely prejudicial, and should always be removed before the application of sponge, or any fungous substance"; they all agree in attributing the suppression of the Hemorrhage to the contraction of the extremety of the artery wholy —

The notice which has been taken of the different theories brings me to that of Mr John Bell, who has been most liberal in his abuse of the sentiments of all those, who differ from him in opinion, without awarding merit where merit existed; for it appears to me that his ideas are the same as those of M Pouteau slightly modified: in illustration of this opinion, I quote from his first volume of the

principles of surgery page 179. "When hemorrhage stops of its own accord, it is neither from the retraction of the artery, nor the constriction of its fibres, nor the formation of clots; but by the cellular tissue which surrounds the artery being infected with blood"; in this I cannot detect that obscurity complaned of by Mr Jones, neither do I think that the illustrations which follow (and which are too lengthy for insertion here) tend to perplex it more. The idea which he wishes to inculcate is simply this - that the infection of the cellular membrane is sufficient to stop the flow of blood in the small arteries, which it would be wholely inadequate to do in those of a larger size, unless assisted by the ligature. Now in what I ask consists

the difference between this theory, and that of Pouteau; "gonflement des chairs, et du tissu cellulaire" I conceive to be nothing more or less than this infection of the "cellular substance" on which Mr Bell lays his claims to originality. I am aware that an objection may be made to these remarks in as much as "gonflement" may mean a swelling from any other cause than that of blood, but this Mr Pouteau has expressed by "tumefaction", and it is not to be supposed that he would have used two words to express the same idea. such tautology is not common among medical writers where accuracy of description is absolutely necessary to convey their meaning, and would have been unpardonable in this instance. Considering the very slender grounds

Mr Bell's claims to originality are placed, we wonder at the unmerciful abuse that he has lavished on those who differ from him in opinion, and whose errors were so many beacon-lights in a devious track. Petit has fallen under his particular displeasure, and that too according to his own confession for "perhaps the only wrong thing that he ever did". "Mr Gooch and Mr B. Bell the alter ipse of Mr Gooch" he continues, "have persecuted him (Petit) with such praise as they could bestow; Petit's spirit has fully expiated this one fault: nothing can be more dangerous to a man's posthumous fame than to have those things commended, and recorded which should in mercy be forgotten (P 172) Again "this miserable theory like a sickly child became every day dearer to Petit,

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and he never thought he could do enough to protect and strengthen it".

Most of the theories heretofore mentioned ascribe the suppression of hemorrhage to one particular cause, but the experiments of Mr. Jones incontestably prove that this process is the effect of a combination of causes, each one performing its part in the great work — the blood, the action of the arteries depending on their physiological structure, their sheaths, the cellular membrane surrounding them, and in one word all the parts concerned in hemorrhage contribute either directly or indirectly: It is to his exertions, and indefatigable industry, that the medical world are indebted for correct notions on this very important subject; his opinions are based on the result of a vast number of experiments, conducted under circumstan-

=ces the most favourable for the elucidation of truth. from these it appears that a violent gush of blood, the retraction of the artery within its sheath, together with a slight contraction of its extremity are the immediate, and almost simultaneous effects of its division; this contraction is in degree prevented by the stream of blood, which diffuses itself into the cellular substance between the veſsel and its sheath, and either flows externally, or infects the cellular membrane in the neighbourhood of the sheath, according to the extent of the wound. By the retraction of the artery within its sheath, and consequent stretching, and laceration of the cellular substance between them, a nidus is offered which entangles the blood in its paſsage outwards, until a coagulum is completed, which blocks up the mouth of the veſsel;

this is what Mr Jones has named the external coagulum, and is the first barrier that is offered to the flow of blood; this coagulation is moreover considerably assisted in many cases by the well known fact that the blood has a tendency to coagulate in proportion to the quantity lost, and the diminution of the force of circulation. The flow of blood being arrested in the artery, a small slender coagulum is formed within it denominated the internal. The extremity of the artery now inflames, and its vessels - the vasa vasorum, pour out coagulating lymph, which is effused between the two coagula, adhereing to them, this substance becoming organized effects the permanent suppression of hemorrhage. The gradual obliteration of the artery soon after takes place by an

effusion of lymph between its coats, and into the contiguous cellular tiſsue, these become thickened and so completely blended and confounded with each other that they cannot be distinguished.

In the mean time the external coagulum so neceſsary in arresting the immediate flow of blood becomes absorbed, the coagulating lymph deposited at its mouth and between its tunics is gradually removed, & the artery aſsumes a ligamentous appearance as high as the first anastomosing branch. These different changes can only be observed for a short period after the receipt of the injury, for then nature sets about a more complete reparation, if the parts be examined at a later period, it will be found that the ligamentous substance has been reduced to a mere filament, which can

can only be distinguished from the surrounding cellular tissue by its firmer and coarser feel.

Before these changes are completely accomplished the branches both above, and below the wound are so enlarged, and have so anastomosed with each other, that they carry on the circulation as perfectly, and vigorously as if the main artery were entire.

The internal coagulum plays such a subordinate part in arresting hemorrhage, that I have as yet merely metioned its existence; in fact it does not always exist, for if the artery be divided very near the place where a branch is given of, none can be detected, and it appears that its length is dependent entirely upon this circumstance*: in simple incised wounds the internal coagulum is of little consequence, but when the parts have been

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* Jones Page 63.

lacerated, and the internal coat of the artery has suffered violence, then this coagulum may extend beyond the first collateral branch in consequence of the effusion of lymph from the wounded parts of the internal coat, and may serve an important purpose.

A similar state of things takes place in the inferior portion of the artery, or that farthest removed from the source of the circulation, the external coagulum however is smaller and the contraction of the extremity of the vessel greater.

The complete division of an artery does not happen in every instance. it may be wounded or partially divided by a cutting instrument as sometimes happens in an incised wound; or it may be transfixed, or barely punctured by the point of a sharp penetrating instrument, as in those

species of wounds called punctured, and the difficulty which nature will encounter in the suppression of the hemorrhage from such wounds will be in proportion to their extent and direction; one moment's reflection must convince us that longitudinal, transverse, or oblique wounds will differ in the size of the aperture, which they leave in an artery; this depends on the properties of elasticity, and contractility inherent in the coats: a wound in the direction of the course of the artery will occasion the least gaping, that obliquely across it will gape in propotion to its size, and a transverse incision however small says Mr Jones, produces a a circular aperture.

When an artery has been merely punctured by a penetrating instrument there is immediately an effusion of blood between

its accompanying sheath and its external tunic, this partially distends the sheath, and the orifice in it, and that in the artery, which before were immediately opposite to each other have their relative situations changed; a thin coagulum of blood becomes interposed, which blocks up the puncture in the artery and prevents further hemorrhage. this coagulum like the external one in divided arteries arrests the flow in the first instance, and gives nature an opportunity of substituting a more effectual barrier, by the effusion of coagulating lymph from the lips of the wound; this lymph seems to become organized, and forms a bond of union between the divided parts, which are so completely repaired, as to leave little, or no obstruction to the arterial canal: to

illustrate this position I bring forward an experiment of Mr Jones. "The brachial artery of a large dog was punctured with a lancet as high up as it could be conveniently got at: thirty days after, the animal was killed, and the head, and fore-legs injected from the aorta; on diſsecting the axillary and brachial arteries of each extremity, not the slightest difference could be perceived and it was impoſsible from bare examination to determine which had been punctured. The cellular membrane however around the wounded artery, was still somewhat thickened, and adhered to the artery, but could be easily separated ~~from~~ it."

When however the wound in the artery is considerable altho' union may take place, the quantity of coagulating lymph

is so great that the caliber of the artery becomes more or less blocked up by it; Irritation kept up by a seaton passed throug the artery seems to produce a similar effect), Dr Jameson of Baltimore transfixed the carotid artery of a sheep with a common crooked needle armed with a tapering buckskin ligature: the two ends were cut off at a small distance from the vessel, and the wound allowed to take its own course. Twenty two days after the experiment the animal was killed: the artery was greatly thickened in its coats about an inch above and below the seton: no traces of a wound was discoverable on one side of the artery, on the other a slight depression was found in which a small part of the buckskin ligature remained reduced to a pulp,

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the sides of the veſsel were closely in contact but not quite united; a small flat opening was seen, through which a very small probe might have been paſsed. There is no doubt continues Dr Jameson that this veſsel which was gradually contracted in its calibre would in a short time have been quite obliterated, and we are quite sure that no blood circulated through it at the time the animal was killed".

When the wound in the artery is greater than in the cases above supposed, quite a different state of things takes place. Owing to the natural contractility of the arterial coats the divided parts are kept continually on the stretch, and in the space of a short time the artery is torn completely through, or else the

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irritation which results from this cause induces ulceration by which the separation is brought about

The similarity of structure between the animals, which have been the subjects of the above experiments, and that of man, would lead us to believe that similar causes would produce similar effects in each; and such I believe would be the case, were the circumstances which follow the reception of an injury, in both cases alike: Mr. Jones had occasion to notice that whenever an animal, which was the subject of an experiment had suffered severely from hemorrhage that it manifested a great disinclination to motion, lying whole days sometimes in the same position without touching the food that was placed before him, but in man the case is quite different, for it is

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a difficult matter to enforce absolute rest and abstinence. it is not an uncommon thing however to see wounds do well, where our anatomical knowledge must assure us; that important blood vessels have been wounded. it is also a rare circumstance that we have an opportunity to examine the state of an artery that has been injured. and even if we had what are we to expect since analogy teaches us that the injury ~~it~~ cannot be detected? Let it not be understood however that I am an advocate for giving nature in every instance. a fair chance to accomplish the suppression of hemorrhage in these cases. there may be circumstances in the economy of man which in a great measure prevent those salutary operations we see in the lower order of animals. and where the life of an individual is at hazard, we are erring on

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the safe side to make use of those measures which art has pointed out as a certain means of remedy — here we have something that the common experience of mankind has pronounced effectual, the other to say the least of it is doubtful, and this I hold to be a safe rule in practice "quod non apparentibus, et non existentibus eadem est ratio".